

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Currently Amended) An optical information recording medium comprising:
a transparent substrate having a first surface and a second surface;
a recording layer that is arranged on the first surface of the transparent substrate,
wherein a hologram is recorded in the recording layer when a signal light and a
reference light are incident from an incident side opposite to the transparent substrate,
[[and]]

a region in the recording layer, in which the hologram is recorded, is conical, and
an optical density of the recording layer corresponding to the signal light
decreases from the incident side toward the transparent substrate; and
a reflection layer arranged on the second surface of the transparent substrate.

2. (Currently Amended) The optical information recording medium according to
claim 1, wherein the decrease of the optical density of the recording layer is continuous
~~continuously decreases from the incident side toward the transparent substrate.~~

3. (Currently Amended) The optical information recording medium according to
claim 1, wherein the decrease of the optical density of the recording layer is step-by-
step decreases ~~stepwise from the incident side toward the transparent substrate.~~

4. (Original) The optical information recording medium according to claim 1, wherein the optical density $S(z)$ at a depth z in the recording layer is within a range expressed as

$$0.5 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2 \leq S(z) \leq 2.0 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2$$

where S_0 is the optical density on a surface of the incident side of the recording layer at $z=0$, n_1 is a refractive index of the recording layer, A is a numerical aperture of a lens, r_0 is a radius of a spot of the signal light on the surface of the incident side, and z is a distance from the surface of the incident side into the recording layer.

5. (Original) The optical information recording medium according to claim 1, further comprising:

a groove that is arranged on the second surface of the transparent substrate to form a track, wherein the optical density $S(r, z)$ at a predetermined position in the recording layer is within a range expressed as

$$0.5 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2 \exp\left(\frac{2r^2}{r_0^2}\right) \leq S(r, z) \leq 2.0 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2 \exp\left(\frac{2r^2}{r_0^2}\right)$$

where S_0 is the optical density of a center of a spot of the signal light at $r=0$ on a surface of the incident side of the recording layer at $z=0$, n_1 is a refractive index of the recording layer, A is a numerical aperture of a lens, r_0 is a radius of the spot of the signal light on the surface of the incident side, r is a distance from the center of the spot in a direction across the track, and z is a distance from the surface of the incident side into the recording layer.

6. (Original) The optical information recording medium according to claim 1, further comprising:

a groove that is arranged on the second surface of the transparent substrate to form a track, wherein at a same depth position of the recording layer, the optical density of an area of the recording layer corresponding to the groove is lower than the optical density of other area.

7. (Original) The optical information recording medium according to claim 1, further comprising:

a groove that is arranged on the second surface of the transparent substrate to form a track,

wherein the recording layer includes areas having different optical densities at a same depth position, and

an area having a lower optical density is arranged at a nearer position to the groove than an area having a higher optical density.

8. (Currently Amended) An optical information recording medium comprising:
a transparent substrate having a first surface and a second surface;
a recording layer that is arranged on the first surface of the transparent substrate,
wherein a hologram is recorded in the recording layer when a signal light and a
reference light are incident from an incident side opposite to the transparent substrate,
[[and]]

a region in the recording layer, in which the hologram is recorded, is conical, and
an optical density of a part of the recording layer corresponding to the signal light
decreases from the incident side toward the transparent substrate, and an optical density
of the remaining part of the recording layer is uniform; and
a reflection layer arranged on the second surface of the transparent substrate.

9. (Currently Amended) An optical information recording medium comprising:
a transparent substrate having a first surface and a second surface;
a recording layer that is arranged on the first surface of the transparent substrate,
wherein a hologram is recorded in the recording layer when a signal light and a
reference light are incident from an incident side opposite to the transparent substrate,
a region in the recording layer, in which the hologram is recorded, is conical, and
the recording layer includes a high optical density [[area]] layer and a low optical
density [[area]] layer corresponding to the signal light, and
the high optical density [[area]] layer is arranged on the incident side relative to the
low optical density [[area]] layer; and
a reflection layer arranged on the second surface of the transparent substrate.

10. (Withdrawn) A method of manufacturing an optical information recording medium that includes a recording layer in which a hologram is recorded and a transparent substrate that has a first surface and a second surface, the method comprising:

depositing a first recording film on the first surface of the transparent substrate; and
depositing a second recording film having a higher optical density than the first recording film on the first recording film.

11. (Withdrawn) A method of manufacturing an optical information recording medium that includes a recording layer in which a hologram is recorded and a transparent substrate that has a first surface and a second surface, the method comprising:

depositing the recording layer on the first surface of the transparent substrate; and
irradiating a light to decrease an optical density on the recording layer from a side of the second surface of the transparent substrate.

12. (Withdrawn) A method of manufacturing an optical information recording medium that includes a recording layer in which a hologram is recorded and a transparent substrate, the method comprising:

depositing the recording layer on a surface of the transparent substrate; and
doping a sensitizer into the recording layer from a light incident side.

13. (Currently Amended) A method of recording information in an optical information recording medium, the optical information recording medium including:

a transparent substrate having a first surface and a second surface;
a recording layer that is arranged on the first surface of the transparent substrate,
wherein a hologram is recorded in the recording layer when a signal light and a reference light are incident from an incident side opposite to the transparent substrate, a region in the recording layer, in which the hologram is recorded, is conical, and an optical density of the recording layer corresponding to the signal light decreases from the incident side toward the transparent substrate; and

a reflection layer arranged on the second surface of the transparent substrate,
the method comprising:

recording the hologram in the recording layer by irradiating the optical information recording medium with the signal light and the reference light through a lens, wherein

the optical density $S(z)$ at a depth z in the recording layer is within a range expressed as

$$0.5 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2 \leq S(z) \leq 2.0 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2$$

where S_0 is the optical density on a surface of the incident side of the recording layer at $z=0$, n_1 is a refractive index of the recording layer, A is a numerical aperture of the lens, r_0 is a radius of a spot of the signal light on the surface of the incident side, and z is a distance from the surface of the incident side into the recording layer.

14. (Currently Amended) A method of recording information on an optical information recording medium, the optical information recording medium including:

- a transparent substrate having a first surface and a second surface;
- a recording layer that is arranged on the first surface of the transparent substrate, wherein a hologram is recorded in the recording layer when a signal light and a reference light are incident from an incident side opposite to the transparent substrate, a region in the recording layer, in which the hologram is recorded, is conical, and an optical density of the recording layer corresponding to the signal light decreases from the incident side toward the transparent substrate;
- a reflection layer arranged on the second surface of the transparent substrate; and
- a groove that is arranged on the second surface of the transparent substrate to form a track,

the method comprising:

- recording the hologram in the recording layer by irradiating the optical information recording medium with the signal light and the reference light through a lens,
- wherein the optical density $S(r, z)$ at a predetermined position in the recording layer is within a range expressed as

$$0.5 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2 \exp\left(\frac{2r^2}{r_0^2}\right) \leq S(r, z) \leq 2.0 \times \frac{S_0}{r_0^2} \left(r_0 - \frac{A/n_1}{\sqrt{1 - (A/n_1)^2}} z \right)^2 \exp\left(\frac{2r^2}{r_0^2}\right)$$

where S_0 is the optical density of a center of a spot of the signal light at $r=0$ on a surface of the incident side of the recording layer at $z=0$, n_1 is a refractive index of the recording layer, A is a numerical aperture of the lens, r_0 is a radius of the spot of the signal light on the surface of the incident side, r is a distance from the center of the spot in a direction across the track, and z is a distance from the surface of the incident side into the recording layer.